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(54) NON-LINEAR CANCELER

(57)Abstract:

PURPOSE: To automatically calculate an intersymbol interference (ISI) value without any control from the outside by calculating ISI data from the output signal value of a linear equalizer and an identified value and successively updating the ISI at the relevant address of a RAM.

CONSTITUTION: The waveform of a regenerative signal is formed by a linear equalizer 11, and this output is temporarily identified by a first binary identifier 12. This temporarily identified value is defined as an address for a look-up table 14 of delay 12 by a 2n-step delay line 13. This address is stored in the

table 14. On the other hand, the output of the equalizer 11 is delayed by an n-step delay line 15 and inputted to an arithmetic circuit 16. Then, the output of the table 14 is subtracted from the output of the delay line 15, this result is inputted to a second binary identifier 17, the output of the circuit 16 is identified, and the finally identified value is outputted. Further, the 151 data are calculated, and the table 14 is written in the RAM by an ISI calculating circuit 18.

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CLAIMS

[Claim(s)]

[Claim 1] A linear equalization machine and the discernment means which

carries out temporary discernment of the output signal of this linear equalization machine, The look-up table which memorizes the data of the intersymbol interference produced approximately with the combination as a result of said several bits temporary discernment and which is constituted by the storage means, The means which changes the combination of a several bits temporary discernment result into the address of the storage means of said look-up table approximately, and reads the contents of said look-up table, A means to subtract the data of the intersymbol interference obtained from said look-up table from the output of said linear equalization machine, The data of an intersymbol interference are calculated from the output signal of a means to identify the output of this means to subtract, and the output signal of said linear equalization machine and said means to identify. The nonlinear canceller which has the count means of the data of the intersymbol interference which updates serially the contents of the applicable address of the storage means of a look-up table.

[Claim 2] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table in a nonlinear canceller according to claim 1 is 0. The count means of the data of said intersymbol-interference signal from the result of temporary discernment of the output signal of said linear equalization machine, and the output signal of said equalizer Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 3] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table in a nonlinear

canceller according to claim 1 is 0. From the output signal of a means to identify the output signal of said linear equalization machine, and said output of a means to subtract, the count means of the data of said intersymbol-interference signal Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 4] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table in a nonlinear canceller according to claim 1 is 0. The count means of the data of said intersymbol-interference signal from the result of temporary discernment of the output signal of said linear equalization machine, and the output signal of said equalizer Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 5] The initial value of the data of the intersymbol interference

memorized by the storage means of said look-up table in a nonlinear canceller according to claim 1 is 0. From the output signal of a means to identify the output signal of said linear equalization machine, and said output of a means to subtract, the count means of the data of said intersymbol-interference signal Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 6] The discernment means which carries out temporary discernment of the output signal of said linear equalization machine in claim 1, claim 2, claim 3, claim 4, or a nonlinear canceller according to claim 5, and a means to identify said output of a means to subtract are 3 value discrimination circuits, and are a partial response to the output side of each of said 3 value discrimination circuit. Nonlinear canceller characterized by arranging a class IV decoder.

[Claim 7] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table in claim 2, claim 3, claim 4, claim 5, or a nonlinear canceller according to claim 6 is a nonlinear canceller [claim 8] characterized by being intersymbol-interference data memorized before renewal of a look-up table. Partial response which carries out temporary discernment of the output signal of a linear equalization machine, and outputs a condition with a discernment result The Viterbi decoder for Classes IV, Said discernment result and a means to change the combination of said condition into the address of the storage means of a look-up table, A means by which said discernment result is delayed, and a means

to subtract the data of the intersymbol interference memorized by the storage means of said look-up table from said discernment result, Partial response which identifies the output signal of said means to subtract Nonlinear canceller characterized by having the Viterbi decoder for Classes IV.

[Claim 9] It sets to a nonlinear canceller according to claim 8, and is said partial response. The Viterbi decoder for Classes IV is a nonlinear canceller characterized by consisting of Viterbi decoders for NRZI of 2 juxtaposition.

[Claim 10] A discernment result and a means to change the combination of said condition into the address of the storage means of a look-up table, A means by which said discernment result is delayed, and a means to subtract the data of the intersymbol interference memorized by the storage means of said look-up table from said discernment result, Partial response which identifies the output signal of said means to subtract The Viterbi decoder for Classes IV is made into 1 configuration unit. Partial response which makes multistage connection of this configuration unit, carries out temporary discernment of the output signal of a linear equalization machine, and outputs a condition to the input side of said configuration unit by which multistage connection was made with a discernment result Nonlinear canceller characterized by having the Viterbi decoder for Classes IV.

[Claim 11] It sets to a nonlinear canceller according to claim 10, and is said partial response. The Viterbi decoder for Classes IV is a nonlinear canceller characterized by consisting of Viterbi decoders for NRZI of 2 juxtaposition.

[Claim 12] The nonlinear canceller characterized by having the count means of the data of the intersymbol interference which calculates the data of an intersymbol interference from the output signal of said linear equalization machine, and the output signal of said Viterbi decoder to identify, and updates serially the contents of the applicable address of the storage means of a look-up table in claim 8, claim 9, claim 10, or a nonlinear canceller according to claim 11.

[Claim 13] In a nonlinear canceller according to claim 12, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal The output signal of said linear equalization machine,

From the result of temporary discernment of the output signal of said equalizer, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 14] In a nonlinear canceller according to claim 12, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal The output signal of said linear equalization machine, From the output signal of a means to identify the output of said means to subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 15] In a nonlinear canceller according to claim 12, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal The output signal of said linear equalization machine, From the output signal of a means to identify the output of said means to

subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 16] In a nonlinear canceller according to claim 12, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal The output signal of said linear equalization machine, From the result of temporary discernment of the output signal of said equalizer, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 17] In a nonlinear canceller according to claim 12, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal The output signal of said linear equalization machine, From the output signal of a means to identify the output of said means to

subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. The nonlinear canceller characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[Claim 18] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table in claim 14, claim 15, claim 16, or a nonlinear canceller according to claim 17 is a nonlinear canceller characterized by being intersymbol-interference data memorized before renewal of a look-up table.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention equalizes the regenerative-signal wave of a nonlinear canceller, especially magnetic storage, and relates to the nonlinear canceller which identifies record data.

[0002]

[Description of the Prior Art] Hereafter, the conventional playback equalizer is explained. In digital magnetic recorder and reproducing devices, such as a digital video tape recorder, the record data of a digital format are once changed into the signal of analog format, and are memorized on a magnetic storage medium. therefore -- the time of playback of the record data of the above-mentioned digital format -- the time -- a storage -- recording -- having --

before -- a digital format -- information will be acquired from the regenerative signal of the analog format detected from a magnetic storage medium. For this reason, the filter called the playback equalizer which operates the wave of a regenerative signal orthopedically so that there may be as much as possible few intersymbol interferences (ISI) is used.

[0003] Linear equalization machines (LE), such as a transversal filter which combines the analog filter and delay line by the coil (L) and the capacitor (C) with a serial, and is constituted, are usually used for this playback equalizer. The regenerative signal after passing along these linear equalization machines will be inputted into a threshold discrimination circuit, and a regenerative signal will be returned to the data (playback data) of a digital format from size with a certain threshold.

[0004] However, since a linear equalization machine tends to double with desired frequency characteristics, without distinguishing the signal component and noise component of a regenerative signal when a linear equalization machine is used as a playback equalizer, the fault that a noise will be emphasized arises. For this reason, a suitable trade-off of the frequency characteristics of a playback equalizing circuit and S/N is taken, and there is a trouble that it is necessary to adjust so that the error rate of the playback data of a final digital format may become min. In order to solve this trouble, there are two approaches described below.

[0005] Hereafter, the approach using the Viterbi decoder as a playback equalizer is explained. The 1st approach is the approach of identifying using S/N which a regenerative signal has using the Viterbi decoder to the maximum extent. Combination with a discernment value [before it] of m bits defines n conditions distinguished with the value of ISI specified beforehand in the Viterbi decoder, and n conditions of the above whenever processing for 1 bit finishes are updated by the following n conditions. Said each n condition has the old hysteresis and the likelihood of a discernment value.

[0006] If it assumes that a noise carries out Gaussian distribution, the likelihood of each n condition will become the old sum of the square of the difference of the value of a regenerative signal in case a noise does not exist, and the value of an actual regenerative signal. While said each n condition is

judged to be what changed from that to which likelihood becomes large most in the condition in front of possible all and being updated by the following condition from a front condition, the hysteresis and likelihood of a discernment value are also updated.

[0007] Thus, if condition transition which will seemingly be the most reasonable is repeated, the hysteresis of a several bits before will be unified into one hysteresis in a certain phase, and the discernment value till then will be decided. Since it identifies in the maximum owner effect by this approach using the signal power of a regenerative signal, a very good error rate is obtained compared with the usual threshold discernment.

[0008] since [however,] it is necessary to calculate the square sum -- a circuit scale -- large -- becoming -- in addition -- and since there is a big trouble that it is difficult to make it operate with the clock of a data rate, the Viterbi decoder of many conditions is not put in practical use in a digital video tape recorder.

[0009] Application to NRZI is as easiest example of the Viterbi decoder. Record playback is carried out by NRZI, if equalized like, the number of conditions will be in two conditions, and since the need for which a unit pulse takes the value of (1, -1) of calculating the square sum is also lost, the Viterbi decoder can be constituted easily. Furthermore, after PURIKODINGU [them / twisting record data to 2 bit delay and mod2 addition and] using a PRIV method, record playback is carried out, and it will be set to NRZI if are equalized that a unit pulse seems to take the value of (1, 0, -1), and it sees at intervals of a bit.

[0010] Therefore, the easy Viterbi decoder for NRZI is used for two-piece juxtaposition, and if it is made to operate with the speed of the one half of a data rate, it will become applicable to NRZI. Since a circuit scale and a working speed can constitute the practical Viterbi decoder, the combination of this PRIV method and the Viterbi decoder is becoming general in the latest digital video tape recorder. Generally about the contents of the explained technique so far, it is known, for example, is indicated by **********, a "digital video record technique", etc.

[0011] Hereafter, the thing of the Viterbi decoder for PRIV is described also as

VD. In VD described above, when it assumes that there is no correlation in a noise and Gaussian distribution is carried out to it, compared with threshold discernment, there is a 3dB S/N improvement effect theoretically. However, since it was difficult for a noise to have correlation and to actually equalize by letting a linear equalization machine pass as the criteria of PRIV, there was a trouble that only the improvement effect expected with the Viterbi decoder was unrealizable.

[0012] Hereafter, the approach using a nonlinear-equalization machine as a playback equalizer is explained. Another approach is the approach of oppressing an intersymbol interference (ISI), without emphasizing a noise using nonlinear-equalization machines, such as a linear canceller (LC) and a nonlinear canceller (NLC). These set up beforehand the copy of ISI determined with the combination of the temporary discernment value of the bit of order, and after they deduct this from the output signal of a linear equalization machine, they identify it once again. NLC is an effective method also to nonlinear distortion to LC being effective only to linear strain.

[0013] the die length of ISI produced according to an identification error although there are various approaches about the configuration approach of the playback equalizer which used NLC -- enough -- it can take into consideration -- in addition -- and the table-look-up mold NLC is one of those to which circuitry becomes easy. After the table-look-up mold NLC makes RAM which stored the data of ISI beforehand a look-up table, changes the combination of the temporary discernment value of a bit before and after identifying by the threshold discrimination circuit based on the output signal of a linear equalization machine into the address, reads the value of ISI and deducts this from a regenerative signal, it is identified by the threshold discrimination circuit once again.

[0014] Drawing 12 is drawing showing the configuration of the conventional playback equalizer 7. Hereafter, actuation of the conventional playback equalizer 7 is explained with reference to drawing 12 . Temporary discernment value A [k] (A[k] =1 or 0) by which temporary discernment was carried out by the first binary discrimination circuit 12 based on the regenerative signal X of the linear equalization machine 11 [k] becomes the

address {A} of a look-up table 14 by the 2n a step of delay line 13.

[0015] The address {A} is 2nbit and is determined by 2n piece temporary discernment value A [i] excluding temporary discernment value A [k'] (however, k'=k-n) from temporary discernment value [of the individual which is the result of identifying the regenerative signal X [k] before deducting ISI (2n+1)] A [i] (i=k, k-1, ..., k-2n).

[0016] In order to remove ISI produced with combination with a temporary discernment value of every n bits approximately, RAM (not shown) built in a look-up table 14 needs to have the capacity which can memorize 22n ISI data. a look-up table -- 14 -- from -- reading -- having had -- the address -- {-- A --} -- ISI -- data -- ISI -- {-- A --} -- an arithmetic circuit -- 16 -- setting -- n -- a step -- a delay line -- 15 -- an output -- X -- [-- k -- ' --] -- from -- deducting -- ISI -- removing -- having had -- a regenerative signal -- Y -- [-- k -- ' --] -- making -- this -- the -- two -- binary -- a discrimination circuit -- 17 -- having identified -- discernment -- a value -- A -- ' -- [-- k -- ' --] -- a final discernment value -- carrying out .

[0017] In this conventional playback equalizer 7, since it only has RAM for look-up table 14, circuitry is very easy, and NLC which removes ISI in consideration of the bit of order long enough can be realized easily.

[0018] However, since the data of ISI which needs to write the data of ISI in RAM and should adjust them beforehand increase in number by 2 n-th power of 2, if it takes 5 bits into consideration at a time approximately, it is necessary to set up 1024 kinds of ISI data, for example.

[0019] The big effort for adjusting this ISI data one by one arises. Therefore, about 16 every 2 bits kinds are limitations practically approximately, and the merit on the circuitry of the conventional playback equalizer 7 cannot fully be harnessed. In order to solve this trouble, there should just be a method of setting up the data of ISI automatically. However, there was no method of setting up the data of ISI automatically until now.

[0020] Moreover, also in any of LC and NLC which are contained in a nonlinear-equalization machine, in order to deduct the value of suitable ISI from a regenerative signal, it becomes a prerequisite that there are few errors included in a temporary discernment value. However, since the error was

inevitably included in the temporary discernment value, the improvement effect by NLC deteriorated in the bottom of an actual condition, and there was a trouble that an error spread.

[0021]

[Problem(s) to be Solved by the Invention] As stated above, the line type equalizer (LC), the Viterbi decoder (VD), or the non-line type equalizer (NLC) is being used for the conventional playback identification approach as a playback equalizer. For this reason, since a linear equalization machine tends to double with desired frequency characteristics, without distinguishing the signal component and noise component of a regenerative signal when a line type equalizer is used as a playback equalizing circuit as stated above, the fault that a noise will be emphasized arises. For this reason, the suitable trade-off of the frequency characteristics of a playback equalizing circuit and S/N was taken, and there was a trouble that it was necessary to adjust so that the error rate of the playback data of a final digital format may become min.

[0022] Moreover, since it was difficult in the playback identification approach using VD as a playback equalizer for a noise to have correlation and to actually equalize as the criteria of PRIV by letting a linear equalization machine pass as stated above, there was a trouble that only the improvement effect expected by VD was unrealizable.

[0023] Moreover, since the data of ISI which needs to write the data of ISI in RAM and should adjust them beforehand in the playback identification approach using the nonlinear decoder as a playback equalizer increase in number by 2 n-th power of 2 as stated above, if it takes 5 bits into consideration at a time approximately, it is necessary to set up 1024 kinds of ISI data, for example.

[0024] The big effort for adjusting this ISI data one by one arises. Therefore, about 16 every 2 bits kinds are limitations practically approximately, and there was a trouble that the merit on circuitry could not fully be employed efficiently.

[0025] Moreover, also in any of LC and NLC, in order to deduct the value of suitable ISI from a regenerative signal, it becomes a prerequisite that there are few errors included in a temporary discernment value. However, since the error was inevitably included in the temporary discernment value, the

improvement effect by NLC deteriorated in the bottom of an actual condition, and there was a trouble that an error spread.

[0026] This invention is made in view of the trouble of a Prior art which was described above, and is set to NLC of a table-look-up mold. The adjustments from the outside including initial setting are not needed, and the bit of order long enough can be taken into consideration. Moreover, a tape, and change and dispersion of the property of a head can be compensated. Moreover, even if it can lessen the error included in a temporary discernment value and the error is included in the temporary discernment value, there is little propagation of an error. Moreover, while an intersymbol interference decreases, correlation of a noise can decrease, a signal power deployment can be aimed at, and it can realize by easy circuitry, and aims at offering the nonlinear canceller from which a good error rate is obtained.

[0027]

[Means for Solving the Problem] In order to solve the technical problem stated above, the nonlinear canceller of this invention A linear equalization machine and the discernment means which carries out temporary discernment of the output signal of this linear equalization machine, The look-up table which memorizes the data of the intersymbol interference produced approximately with the combination as a result of said several bits temporary discernment and which is constituted by the storage means, The means which changes the combination of a several bits temporary discernment result into the address of the storage means of said look-up table approximately, and reads the contents of said look-up table, A means to subtract the data of the intersymbol interference obtained from said look-up table from the output of said linear equalization machine, The data of an intersymbol interference are calculated from the output signal of a means to identify the output of this means to subtract, and the output signal of said linear equalization machine and said means to identify, and it has the count means of the data of the intersymbol interference which updates serially the contents of the applicable address of the storage means of a look-up table.

[0028] Moreover, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means

of the data of said intersymbol-interference signal from the result of temporary discernment of the output signal of said linear equalization machine, and the output signal of said equalizer Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0029] Moreover, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. From the output signal of a means to identify the output signal of said linear equalization machine, and said output of a means to subtract, the count means of the data of said intersymbol-interference signal Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0030] Moreover, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal from the result of temporary discernment of the output signal of said linear equalization machine, and the output signal of said equalizer Calculate the value of the data of the

intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0031] Moreover, the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. From the output signal of a means to identify the output signal of said linear equalization machine, and said output of a means to subtract, the count means of the data of said intersymbol-interference signal Calculate the value of the data of the intersymbol interference in a certain time, and sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0032] Moreover, the discernment means which carries out temporary discernment of the output signal of said linear equalization machine, and a means to identify said output of a means to subtract are 3 value discrimination circuits, and are a partial response to the output side of each of said 3 value discrimination circuit. It is characterized by arranging a class IV decoder.

[0033] Moreover, it is characterized by the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table being intersymbol-interference data memorized before renewal of a

look-up table.

[0034] moreover -- Partial response which carries out temporary discernment of the output signal of a linear equalization machine, and outputs a condition with a discernment result With the Viterbi decoder for Classes IV Said discernment result and a means to change the combination of said condition into the address of the storage means of a look-up table, A means by which said discernment result is delayed, and a means to subtract the data of the intersymbol interference memorized by the storage means of said look-up table from said discernment result, Partial response which identifies the output signal of said means to subtract It is characterized by having the Viterbi decoder for Classes IV.

[0035] Moreover, said partial response The Viterbi decoder for Classes IV is characterized by consisting of Viterbi decoders for NRZI of 2 juxtaposition.

[0036] Moreover, a discernment result and a means to change the combination of said condition into the address of the storage means of a look-up table, A means by which said discernment result is delayed, and a means to subtract the data of the intersymbol interference memorized by the storage means of said look-up table from said discernment result, Partial response which identifies the output signal of said means to subtract The Viterbi decoder for Classes IV is made into 1 configuration unit. Partial response which makes multistage connection of this configuration unit, carries out temporary discernment of the output signal of a linear equalization machine, and outputs a condition to the input side of said configuration unit by which multistage connection was made with a discernment result It is characterized by having the Viterbi decoder for Classes IV.

[0037] Moreover, said partial response The Viterbi decoder for Classes IV is characterized by consisting of Viterbi decoders for NRZI of 2 juxtaposition.

[0038] Moreover, the data of an intersymbol interference are calculated from the output signal of said linear equalization machine, and the output signal of said Viterbi decoder to identify, and it is characterized by having the count means of the data of the intersymbol interference which updates serially the contents of the applicable address of the storage means of a look-up table.

[0039] The initial value of the data of the intersymbol interference memorized

by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal Moreover, the output signal of said linear equalization machine, From the result of temporary discernment of the output signal of said equalizer, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0040] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal Moreover, the output signal of said linear equalization machine, From the output signal of a means to identify the output of said means to subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0041] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal Moreover, the output signal of said linear equalization machine, From the output signal of a means to identify the

output of said means to subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When the count of this addition becomes the count of fixed, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0042] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal Moreover, the output signal of said linear equalization machine, From the result of temporary discernment of the output signal of said equalizer, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0043] The initial value of the data of the intersymbol interference memorized by the storage means of said look-up table is 0. The count means of the data of said intersymbol-interference signal Moreover, the output signal of said linear equalization machine, From the output signal of a means to identify the output of said means to subtract, the value of the data of the intersymbol interference in a certain time is calculated. Sequential addition of the data of this intersymbol interference is carried out at the temporary value of the data

of the temporary intersymbol interference of the applicable address of the storage means of said look-up table. When fixed time amount progress is carried out from addition initiation, the division of the data of the temporary intersymbol interference of the applicable address is done by this count of addition. It is characterized by updating the contents of the storage means of said look-up table for the average value of the data of the intersymbol interference memorized by the storage means of the value of this division result, and said look-up table as data of a new intersymbol interference.

[0044] Moreover, it is characterized by the initial value of the data of the intersymbol interference memorized by the storage means of said look-up table being intersymbol-interference data memorized before renewal of a look-up table.

[0045]

[Function] ISI is calculated from the value and discernment value of an output signal of a linear equalization machine, by the ISI count circuit which updates serially ISI of the address with which RAM corresponds, no adjustments from the outside also including initial setting are needed, but the value of required ISI can be acquired automatically.

[0046] Moreover, by combining the Viterbi decoder (VD) and NLC for PRIV, the circuitry of a playback equalizer is simplified and a good error rate is obtained. Moreover, using VD as a temporary discrimination circuit of NLC, after removing ISI by NLC based on the discernment value, a still better error rate is obtained by identifying by VD once again.

[0047]

[Example] Hereafter, the first example of this invention is explained. Drawing 1 is drawing showing the configuration of the first playback equalizer 1 of this invention. the -- one -- playback -- an equalizer -- one -- drawing 12 -- the former -- playback -- an equalizer -- seven -- n -- a step -- the -- two -- a delay line -- 15 -- having passed -- the back -- linear equalization -- a vessel -- 11 -- an output -- X -- [-- k -- ' --] -- NLC -- discernment -- a value -- A -- ' -- [-- k -- ' --] -- from -- ISI -- data -- calculating -- a look-up table -- RAM -- writing in -- a function -- having had -- ISI -- count -- a circuit -- 18 -- having added -- a configuration -- becoming -- **** .

[0048] In drawing 1 , the line type equalizer 11 is a line type equalizing circuit which consists of analog filters etc. and performs corrugating of a regenerative signal. The first binary discrimination circuit 12 is a binary discrimination circuit which carries out temporary discernment of the output of the line type equalizer 11. The 2n a step of delay line 13 is a delay circuit which generates the address for look-up table 14 from the temporary discernment value outputted from the first binary discrimination circuit 12.
[0049] A look-up table 14 is a store circuit which consists of RAM and its circumference circuit, and memorizes the value of ISI. n steps of delay lines 15 are delay circuits which the output of the line type equalizer 11 is delayed and are inputted into an arithmetic circuit 16. An arithmetic circuit 16 is an arithmetic circuit which subtracts the output of a look-up table 14 from the output of n steps of delay lines 15. The second binary discrimination circuit 17 is a binary discrimination circuit which identifies the output of an arithmetic circuit 16 and outputs a final discernment value. Each part of the first playback equalizer 1 described above is the same as the part which attached the same sign of the conventional playback equalizer 7. The ISI count circuit 18 is a count circuit with the function which calculates ISI data and is written in RAM of a look-up table.
[0050] Hereafter, the value of the intersymbol interference (ISI) which produces the signal with which the signal with which the signal shown by X[ ] is shown by the regenerative signal after linear equalization and A[ ] is shown by the temporary discernment value and ISI[ ] from the combination of the bit of order, and the signal with which it is shown by Y [the regenerative signal with which the signal shown by] removed the intersymbol interference, and A'[ ] are nonlinear canceller discernment values. Moreover, it is (k'=k-n).
[0051] Drawing 2 is drawing showing the configuration of the ISI count circuit 18. In drawing 2 , RAM180 is RAM which stores the count N of generating {A'} of the value LISI of temporary ISI {A'}, and the address {A'}. ROM181 is ROM which memorizes a count program. CPU182 is CPU which performs actual count.
[0052] Hereafter, actuation of the first playback equalizer 1 is explained. First, the count approach of the ISI data in the ISI count circuit 18 is explained. the

beginning -- RAM -- 180 -- all -- ISI -- a value -- ISI -- {-- A -- ' --} -- and -- temporary -- ISI -- a value -- LISI -- {-- A -- ' --} -- the address -- {-- A -- ' --} -- generating -- a count -- N -- {-- A -- ' --} -- 0 -- carrying out (clear) . That is, ISI {A'} <-0LISI {A'} <- 0N {A'} <- like 0, it is ******. The storage region on the ISI data ISI{A'} temporary ISI data LISI {A'} and RAM180 of the count N of generating {A'} of the address {A'} is set to 0.

[0053] The address determined by [j {j=k', k'-1, ..., k'-2n}] is made into the address {A'}. here -- discernment value A'[-- k -- 'the 2n piece discernment value A except -n]' -- the 2n piece temporary discernment value A except temporary discernment value A [k'] -- it uses in distinction from the address {A} determined by [i {i=k, k-1, ..., k-2n}].

[0054] Next, in addition to LISI {A'} of the address which corresponds considering the temporary recognition signal X [k'-n] and the difference of discernment value B' [k'-n] as a value of a certain instantaneous ISI, the count N of generating {A'} of the address {A'} is increased one. that is, -- LISI -- {-- A -- ' --} -- <- -- LISI -- {-- A -- ' --} -- + -- X -- [-- k -- ' - n --] - B -- ' -- [-- k -- ' - n --] -- The contents of storage of RAM180 are changed like N{A'} <-N{A'}+1.

[0055] Here, the amplitude of the regenerative signal X of the facilities top line type equalizer 11 of explanation [k] is standardized by **1, makes 0 a threshold and is identified by 1 and 0. this time -- discernment value A'[k] =1 -- discernment value B'[k] = -- temporary [to discernment value A'[k] =0] in 1 -- if discernment value B[k] =-1 is made to correspond -- discernment value B', since [k] =**1 becomes the desired value of the regenerative signal X of the line type equalizer 11 [k] The moment there is (X[k]-B' [k]), it becomes the value of ISI of k.

[0056] Next, when only the count M to which temporary ISI of a certain address was set beforehand is added, while calculating the average of temporary ISI by dividing temporary ISI by the count of addition of each address, adding this and ISI of RAM, taking the average and newly writing this in RAM, the count N of generating {A'} of the address {A'} is set to 0. It is got blocked. The contents of storage of RAM180 are changed like ISI{A'} <- (ISI{A'}+LISI {A'} /M)/2 N{A'} <-0.

[0057] Here, it is the same ratio 0.5 about the average of temporary ISI, and

the value of ISI of RAM. : This ratio is (x although the average is taken in addition by 0.5. : If it is 1-x), it is easy to be the thing of arbitration. Moreover, when the working speed of RAM cannot do read-out and the writing of ISI data between one clocks late, while it only supposes that it is to update the count N of generating {A'} of the value LISI of temporary ISI {A'} and the address {A'} and the head and the tape do not touch, the period when the head (not shown) and the tape (not shown) touch updates ISI data, and should just write them in RAM.

[0058] By very easy count which was described above, required ISI data are automatically generable. In addition, since all ISI data are 0 at first, the same thing as temporary discernment value A [k] with the linear equalization machine 11 is outputted to discernment value A' [k]. Therefore, effectiveness of the first playback equalizer 1 cannot be acquired until it updates ISI data several times.

[0059] However, since can read suitable ISI and it cannot be removed when many errors are contained in the temporary discernment value with the linear equalization machine 11, it is the need for the first playback equalizer 1 to use the linear equalization machine 11 with which to some extent good adjustment was made. Therefore, it does not become the fault newly generated by this invention. Rather, the merit with unnecessary initial setting is larger. What is necessary is just to use it for the initial value of ISI {A'}, when there are former ISI data although it is needless to say.

[0060] In the first playback equalizer 1, the ISI data obtained by approach which was stated above by the ISI count circuit 18 are the same approach, and are used for discernment of a regenerative signal as the conventional playback equalizer 7 explained.

[0061] Hereafter, the second example of this invention is explained. It considers as the basic approach of ISI generation of ********** of ISI by the ISI count circuit 18 explained in the first example. In the basic approach, ISI of k' is calculated at a certain moment using discernment value A' [k'] which is the result of identifying regenerative-signal [of the arithmetic circuit 16 after deducting the value of ISI] Y [k'].

[0062] Furthermore, by 2n piece discernment value A' [j] (j=k', k' - 1, ..., k' - 2n)

except discernment value A' [k'-n], 2n a bit of address {A'} is determined, ISI data are created, and it writes in a look-up table 14.

[0063] The ISI data of 2n a bit of address {A} specified by 2n piece temporary discernment value A [i] (i=k, k-1, ..., k-2n) except temporary discernment value A [k'] were read, and it has deducted from the regenerative signal X [k']. The decision approach of the ISI data in the second example explained below is the modification of the basic approach.

[0064] By discernment value A[of the individual containing discernment value A' [k'-n] (2n+1)]' [j] (j=k', k' - 1, ..., k' - 2n), the address {A'} of a bit (2n+1) is determined, ISI data are created, and it writes in a look-up table 14.

[0065] Two data of ISI at the time of discernment value A[k'] =0 {A-} are read to coincidence. temporary, when reading this at temporary discernment value A [i] (i=k, k-1, ..., k-2n) except temporary discernment value A [k'] -- as temporary as ISI at the time of discernment value A[k'] =1 {A+} -- After averaging these two, it deducts from a regenerative signal X [k'].

[0066] In this case, two RAM which stores 22n piece ISI data is prepared, it is made 2 juxtaposition, and applicable discernment value A' [k'] uses properly according to 1 or 0 in the case of ISI data origination. Although a circuit scale becomes large by this approach, the dependability of ISI data improves.

[0067] Hereafter, the third example of this invention is explained. Drawing 3 is drawing showing the configuration of the second playback equalizer 2 of this invention. Each part of the second playback equalizer 2 is the same as the part which attached the same sign of the first playback equalizer 1. With the configuration of the playback equalizer 1 which is the first, ISI data are created and carried out using discernment value A' [k'] which identified regenerative-signal [of the arithmetic circuit 16 after deducting ISI] Y [k']. This is because the discernment value of the first playback equalizer 1 is more reliable than the output of the linear equalization machine 11. However, when there are many defects, or when envelope fluctuation of a regenerative signal is large, dependability may become [the way of the output of NLC] low suddenly at a tape.

[0068] In such a case, when ISI data are created from the result of having identified regenerative-signal [of an arithmetic circuit 16] Y [k'], and

regenerative-signal [of an arithmetic circuit 16] Y [k'] begins to show an unsuitable value, there is risk of ISI data not converging. Then, in the second playback equalizer 2, the result of having identified the regenerative signal X of the linear equalization machine 11 [k] to creation of ISI data is used.

[0069] Both the basic approach and the decision approach of the ISI data in the second example are [equalizer / 2 / second / which was described above / playback] applicable about the count approach in the ISI count circuit 18. When the configuration of the second playback equalizer 2 presupposes that it is the same as that of the first playback equalizer 1, the envelope of a regenerative signal is always supervised and this envelope becomes a defect from the same view, count of LISI {A'} may be stopped.

[0070] Moreover, an error rate may worsen in a latter ECC circuit, things may be detected, and count of LISI {A'} may be stopped in the meantime. Moreover, instead of stopping count of LISI {A'}, you may constitute so that first playback equalizer 1 and playback equalizer of ** second 2 configuration may be changed. Moreover, when an error rate continues deteriorating, it is also effective to take the approach of once clearing all the ISI data of a look-up table 14.

[0071] Hereafter, the fourth example is explained. In each example described above, it explained only within the case where a regenerative signal is identified to the value of (1, 0) using a binary discrimination circuit. In the fourth example, application to PRIV (partial response class IV) of the first playback equalizer 1 and the second playback equalizer 2 is performed as an application of the first playback equalizer 1 and the second playback equalizer 2.

[0072] Drawing 4 is drawing showing the configuration of the third playback equalizer 3 of this invention. In drawing 4 , first 3 value discrimination circuit 21 is 3 value discrimination circuit which carries out temporary discernment of the output of the line type equalizer 11. Second 3 value discrimination circuit 22 is 3 value discrimination circuit which identifies the output of an arithmetic circuit 16. 3 value discrimination circuits 21 and 22 identify **0.5 to the value made into a threshold (1, 0, -1). The first PRIV decoder 22 is for generating the address {A} from temporary discernment value A [k], in order to read

required ISI data.

[0073] The first PRIV decoder 23 is a decoder which carries out PRIV decoding of the output of first 3 value discrimination circuit 21. The second PRIV decoder 24 is a decoder which carries out PRIV decoding of the output of first 3 value discrimination circuit 22. While generating the address {A'} which is needed by this in the ISI count circuit 18, final discernment value A' [k] which consists of 1 and 0 is obtained. The configuration of each part of third playback equalizer 3 other than the above is the same as each part which attached the same sign of the first playback equalizer 1 and the second playback equalizer 2.

[0074] The signal with which the signal shown by B[ ] is shown by the temporary discernment value and B'[ ] is [hereafter,] a nonlinear canceller discernment value, and A'[ ] is a nonlinear canceller discernment value after PRIV decoding.

[0075] The third playback equalizer 3 has composition similar to the first playback equalizer 1. In order to apply the first playback equalizer 1 to PRIV, it is necessary to add a decoder which generates the 2n+2 bit address {A} from the combination of temporary discernment value B [k] which was described above. That is, the third playback equalizer 3 is a point with two 3 value discrimination circuits 21 and 22 and two kinds of PRIV decoders 23 and 24, and differs from the first playback equalizer 1. In addition, as desired value of a regenerative signal X [k], discernment value B' [k] is used as it is. The combination of the decision approach of the ISI data stated also about the application to this PRIV in the above-mentioned basic approach, the second example, and the third example is possible. Moreover, what is necessary is just to change a discernment value into the address of the necessary minimum number of bits using the same decoder, also when applying in addition to PRIV.

[0076] In PRIV, after carrying out PURIKODINGU according record data to 2-bit delay (mod2) addition, it records. After identifying the regenerative signal X [k] equalized using the linear equalization machine 11 to temporary discernment value B [k] which makes **0.5 a threshold and consists it of 1, 0, and -1 so that the response of the regenerative signal over a unit pulse may

be set to (1, 0, -1), 1 and -1 are decoded to 1, 0 is decoded to 0, and it is referred to as temporary discernment value A [k].

[0077] When the address is determined as the first example or second example based on the ISI data count approach, using temporary discernment 2n+1 piece value B [k] as it is, since this is three values, it has the combination of 32n+1. However, in PRIV, an odd number sequence and an even number sequence can consider that it is independent NRZI. therefore, the combination of 22n+1 after decoding to binary (1 and 0) -- in addition, what is necessary is just to consider the condition (two every conditions of 1 or 0) of NRZI of an odd number sequence and each even number sequence

[0078] the bit in front of odd nearest to the bit to which its attention is paid -- un--- it carries out to if 0 is (-1) (Aodd=0), and it carries out to if it is 1 (Aodd=1). the bit in front of even nearest to the bit to which its attention is paid similarly -- un--- if 0 is -1, it will be referred to as (Aeven=0), and it carries out to if it is 1 (Aeven=1).

[0079] By the approach described above, the combination generated with the temporary discernment value of an individual (2n+1) is 22n+3 kind, and since temporary discernment value B [k'] is identified anew, if it is disregarded, it will become the 2n+2 bit address. The example of the relation of the address {A} of temporary discernment value B [k] and temporary discernment value A [k] and (2n+2) a bit is shown for the case of n= 3 in an example at drawing 5 .

[0080] The M sequence of 511 periods is recorded on the digital video tape recorder for an experiment, and the AD translation of the regenerative signal in front of identification is carried out at high speed, and it incorporates to a calculating machine, and equalizes on the criteria of PRIV with the transversal filter of three to 15 tap, and the error rate when comparing a discernment value with record data is shown in drawing 6 .

[0081] An indicating [to be NLC]- drawing 6 thing is a result at the time of applying the third playback equalizer 3 to PRIV. The number of continuous regenerative-signal data is about 20000, and all the initial value of ISI data put in 0, and has updated it by M= 64. That improvement in the biggest error rate in this is obtained is the case where the nonlinear canceller of n= 3 is applied to the transversal filter of seven taps, an error rate is set to 2.46x10-4 from

2.38x10-3, and the error is decreasing to abbreviation (1/10). Although effectiveness also becomes small since an identification error becomes small as the number of taps of a transversal filter increases, the error is decreasing to abbreviation (1/4) by using the nonlinear canceller of n= 3.

[0082] Hereafter, the fifth example is explained. Drawing 7 is drawing showing the configuration of the fourth playback equalizer 4 of this invention. drawing 7 -- setting -- the first Viterbi decoder (VD) 25 -- output signal X of the linear equalization machine 11 [k] the condition of an NRZI sequence of being based, carrying out temporary discernment and corresponding between binary temporary discernment value [of 1 and 0] B [k-m], and each ** -- condition beta [k] ****** -- it is the Viterbi decoder to output. The second Viterbi decoder (VD) 26 is the Viterbi decoder for PRIV which outputs binary discernment value B[of 1 or 0]' [k'-m] based on regenerative-signal [after ISI was deducted] Y [k'].

[0083] It is time amount (period of operation) until the condition of a PRIV relevance a train decides hereafter the signal shown by beta[ ] with the Viterbi decoder (VD) and a discernment result decides m.

[0084] The address generation machine 27 is the combination for 2nbit of temporary discernment value B [i] (i=k-m-2n, ..., k-m, however i!=k-n) by the first Viterbi decoder 25, and condition beta [k-m-n -1]. Condition beta [k-m-n -2] It is the address generation circuit given to a look-up table 14 as the address {A} of a bit (2n+2). (2 n+m) The delay line 28 of a stage is a regenerative signal X [k]. You make it delayed by the period of operation (m+n), and it is the delay output X [k']. It is the delay circuit to output. Each part of the fourth playback equalizer 4 which is not explained here is equivalent to the part which attached the same sign of the first playback equalizer 1. Moreover, the part enclosed with a dotted line is only called NLC10 into drawing 7 .

[0085] Hereafter, actuation of the fourth playback equalizer 4 is explained. the first Viterbi decoder 25 -- output signal X [k] of a line type equalizer (not shown) the condition of an NRZI sequence of carrying out temporary discernment and corresponding between binary temporary discernment value [of 1 or 0] B [k-m], and each ** -- condition beta [k] ****** -- it outputs. m is

the number of bits until a discernment value is decided by VD here.

[0086] The address generation machine 27 is the combination for 2nbit of temporary discernment value B [i] (i=k-m-2n, ..., k-m, however i!=k-n) outputted from the first Viterbi decoder 25, and condition beta [k-m-n -1]. Condition beta [k-m-n -2] The 2n+2 bit address {A} is outputted to a look-up table 14.

[0087] The look-up table 14 which received this address {A} outputs corresponding ISI data to an arithmetic circuit 16. (2 n+m) The delay line 28 of a stage inputs into an arithmetic circuit 16 the delay signal X [k'] which delayed the regenerative signal X [k] by the period of operation (m+n). Here, it is (k'=k-n-m). An arithmetic circuit 16 subtracts said ISI data from the delay signal X [k'], and inputs them into the second Viterbi decoder 26. The second Viterbi decoder 26 outputs binary discernment value B[of 1 or 0]' [k'-m] based on regenerative-signal Y [k'] which subtracted said ISI data from the delay signal X [k'].

[0088] The Viterbi decoders 25 and 26 and the address generation machine 27 which were used here are explained further. The PRIV decoder was required in order to apply to PRIV in each NLC stated in the first example - the fourth example. However, the output of the Viterbi decoders 25 and 26 is already decoded, and the sign when being identified by 1 is used for decode inside the Viterbi decoders 25 and 26 as a condition of NRZI of an even number sequence or an odd number sequence.

[0089] Therefore, a circuit can be simplified by using this for the decision of the address. The Viterbi decoders 25 and 26 use the Viterbi decoder for NRZI codes for 2 juxtaposition an even number sequence and for odd number sequences, and use it as the Viterbi decoder for PRIV. Although the value of Condition beta is used here, this expresses the condition of each sequence. In the usual Viterbi decoder, temporary discernment value B [k-m] is outputted, and although Condition beta is only used inside, it is outputting the condition beta of an NRZI sequence that the moment of calling it k corresponds, as condition beta [k] in the Viterbi decoders 25 and 26 in this invention.

[0090] On the other hand, it is in the condition of each sequence just before temporary discernment value B [k-m-n] decides to k the thing which is the

need as the address {A} at a certain moment. With therefore, the register of - one step of m+n from whom the address generation machine 27 delays condition beta [k] by the m+n-1 actuation period It is constituted by 2n a step of register who stores temporary discernment value B [k-m], and considers as the address {A} combining condition [k-m-n -1] and condition beta [k-m-n -2] and temporary discernment value B [i] (i=k-m-2n, ..., k-m, however i!=k-n).

[0091] Hereafter, the sixth example is explained. Drawing 8 is drawing showing the configuration of the fifth playback equalizer 5 of this invention. The fifth playback equalizer 5 adds said ISI count circuit 18 to the fourth playback equalizer 4. drawing 8 -- setting -- ISI -- count -- a circuit -- 18 -- a stage (2 n+m) -- a delay line -- 28 -- an output signal -- X -- [-- k -- ' --] -- the -- two -- Viterbi -- a decoder -- 26 -- depending -- discernment -- a value -- B -- ' - - [-- k -- ' - m --] -- and -- a condition -- beta -- [-- k -- ' --] -- from -- By internal delay, make X [k'-n-m] and condition beta [k'-m-n -1], condition beta [k'-m-n -2], and discernment value B' [i] (i=k-m-2n, ..., k-m), and ISI data are calculated using these. It is the count circuit which updates the ISI data of a look-up table timely. Each part of the other fifth playback equalizers 5 is the same as each part which attached the sign same about the fourth playback equalizer 4.

[0092] By considering as a configuration like the fifth playback equalizer 5 shown in drawing 8 , a bit discrimination circuit with an unnecessary setup of ISI data is realizable. In addition, since it is necessary to calculate the address of RAM inside the ISI count circuit 18 in this case, condition beta [k'] is taken out also from the second Viterbi decoder 26. any of the ISI count circuit 18 which were explained in each example which stated the ISI count circuit 18 above -- although -- it is applicable.

[0093] Hereafter, the seventh example is explained. Drawing 9 is drawing showing the configuration of the sixth playback equalizer 6 of this invention. The sixth playback equalizer 6 combines the second Viterbi decoder 26, the address generation machine 27, the delay line 28 of a stage (n+m), and a look-up table 14, i.e., NLC and the first Viterbi decoder 26, makes it a unit 9, and makes multistage connection of it. Hereafter, the regenerative signal with which the signal shown by X [k (j)] passed along the delay line 28 of a stage (n+m) j times, and the signal shown by B [k (N)] show the discernment result

by the combination unit (NLC+VD) 9 of N stage.

[0094] The configuration of this combination unit 9 is shown in drawing 10 . Each part shown in drawing 10 is the same as each part which attached the same sign of the fifth playback equalizer 5.

[0095] In the sixth playback equalizer 6, discernment value B' [k-j(n+m)-m] by X [k-j (n+m)] and the j-th step of second Viterbi decoder 26 with which the regenerative signal after linear equalization was delayed is passed to the next stage. That is, the sixth playback equalizer 6 is a bit discrimination circuit for PRIV of a configuration of carrying out multistage association of the above-mentioned combination unit, and allotting the first Viterbi decoder 25 and ISI count circuit 18 forward and backward, as shown in drawing 9 . With the sixth playback equalizer 6, an error rate can be further raised from the fourth playback equalizer 4 and the fifth playback equalizer 5 by reading ISI data and deducting from a regenerative signal with a more reliable temporary discernment value.

[0096] Moreover, since ISI data are created based on the discernment value of VD of the last stage, the dependability of the data itself becomes high rather than the fifth playback equalizer 5. In addition, since it is prescribed by S/N of the regenerative signal after identification, if many number of stageses of said combination unit are taken, the error rate of the upper limit of an error rate will not necessarily improve without limit, and it becomes making [many] a number of stages, and is saturated (B' [k-j(n+m)-m] =B' [k-(j+1) (n+m)-m]). Therefore, it is enough in said 2-3 steps of combination.

[0097] Drawing 11 is drawing showing the error rate at the time of having recorded the M sequence of 511 periods on the digital video tape recorder for an experiment, carrying out the AD translation of the regenerative signal in front of identification at high speed, incorporating to a calculating machine, equalizing on the criteria of PRIV with the transversal filter of three to 15 tap, and comparing a discernment value with record data.

[0098] The number of continuous regenerative-signal data is about 20000, and is equivalent to a part for one truck of this digital video tape recorder for an experiment. NLC applied the thing of n= 3, and all the initial value of ISI data is automatically updated as 0 is put in and discernment progresses. It

was written as TD by drawing 11 as a result of threshold detection, and the result of having applied the bit discrimination circuit equivalent to the fifth playback equalizer 5 shows by VD->NLC->VD. That improvement in the biggest error rate in this is obtained is the case where this invention is applied to the transversal filter of seven taps, and the error is decreasing to abbreviation (1/10) compared with VD and NLC of (1/100) of TD, and a simple substance.

[0099]

[Effect of the Invention] As stated above, according to this invention, it sets to NLC of a table-look-up mold. The adjustments from the outside including initial setting are not needed, and the bit of order long enough can be taken into consideration. Moreover, a tape, and change and dispersion of the property of a head can be compensated. Moreover, even if it can lessen the error included in a temporary discernment value and the error is included in the temporary discernment value, there is little propagation of an error. Moreover, while an intersymbol interference decreases, correlation of a noise can decrease, a signal power deployment can be aimed at, and it can realize by easy circuitry, and the nonlinear canceller from which a good error rate is obtained can be offered.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the configuration of the first playback equalizer of this invention.

[Drawing 2] It is drawing showing the configuration of an ISI count circuit.

[Drawing 3] It is drawing showing the configuration of the second playback equalizer of this invention.

[Drawing 4] It is drawing showing the configuration of the third playback equalizer of this invention.

[Drawing 5] In the third playback equalizer of this invention, it is drawing showing the example of the relation of the address {A} of temporary discernment value B [k], temporary discernment value A [k], and (2n+2) a bit for the case of n= 3 for an example.

[Drawing 6] It is drawing showing the error rate when having recorded the M sequence of 511 periods on the digital video tape recorder for an experiment, carrying out the AD translation of the regenerative signal in front of identification at high speed, incorporating to a calculating machine, equalizing on the criteria of PRIV with the transversal filter of three to 15 tap, and comparing a discernment value with record data.

[Drawing 7] It is drawing showing the configuration of the fourth playback equalizer of this invention.

[Drawing 8] It is drawing showing the configuration of the fifth playback equalizer of this invention.

[Drawing 9] It is drawing showing the configuration of the sixth playback equalizer of this invention.

[Drawing 10] It is drawing showing the configuration of the combination unit of the sixth playback equalizer.

[Drawing 11] It is drawing showing the error rate at the time of having recorded the M sequence of 511 periods on the digital video tape recorder for an experiment, carrying out the AD translation of the regenerative signal in front of identification at high speed, incorporating to a calculating machine, equalizing on the criteria of PRIV with the transversal filter of three to 15 tap, and comparing a discernment value with record data.

[Drawing 12] It is drawing showing the configuration of the conventional playback equalizer.

[Description of Notations]

1 ... First playback equalizer

2 ... Second playback equalizer

3 ... Third playback equalizer

4 ... Fourth playback equalizer

5 ... Fifth playback equalizer

6 ... Sixth playback equalizer

9 ... Combination unit

10 ... NLC

11 ... Line type equalizer

12 ... First binary discrimination circuit

13...2n a step of delay line

14 ... Look-up table

15 ... Delay line of n stage

16 ... Arithmetic circuit

17 ... Second binary discrimination circuit

18 ... ISI count circuit

21 22 ... 3 value discrimination circuit

23 24 ... PRIV decoder

25 26 ... Viterbi decoder

27 ... Address generation machine

28 ... (2 n+m) Delay line of a stage